TEACHER MATERIALS FOR THE

PHYSICS AT THE INDY 500

VIDEO TAPE

An Honors Thesis (HONRS 499)

by

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ALL MY THANKS

TO

DR. RUTH H. HOWES

FOR HER

INSPIRATION, ASSISTANCE, AND HUMOR.

THE NEED TO STUDY PHYSICS

According to the *Random House College Dictionary*, physics is "the science that deals with matter, energy, motion and force" (Random House, 1002). This single word, physics, is capable of generating a myriad of images in the human mind. What aspect of today's world isn't based on physics? This science that is such a mystery to many adults is invariably practiced daily by those same adults. Common occurrences, such as walking down the street, fastening a seatbelt, and turning a TV channel, utilize fundamental laws of physics. Due to this science being indispensable to everyday life, it follows that people of the world should have physics as a part of a general education.

Physics is desirable for all students, not just future scientists and technological experts (Brown 1971, 22). The need for physics is partly due to the materialism of today. A majority of highly prized objects relate directly to the fields of science and technology. VCR's, portable telephones, and compact disk stereo systems are just a few of the latest technological successes. The technological advances of today are made possible by people educated usually twenty to forty years ago. Students educated today may provide the backbone of tomorrow's greatest advances.

All students should have a basic understanding of physics to utilize in the future. Speech teachers do not teach each of their students how to prepare an inaugural speech on the slim chance that a pupil will one day be President of the United States. Who in this world has the foresight to predict which child will be the electronics engineer, the Wall street businessman, or the President of the future? If the future could be predicted for each student, teachers would have a much simpler task. A main aspect of education is to provide students with a background varied enough to assist them in all they encounter in life. "Since the aims of education cannot be attained through the study of a single subject, it is essential that the prospective physics teacher respect the value of the other subjects included in the total curriculum" (Brown 1971, 22).

No one subject could possibly prepare students for the tremendously varied world they face, although several subjects encompass more than do others. Just as the definition states, physics underlies all of life as it is known today. At the International Congress on the Education of Teachers of Physics in Secondary Schools in Hungary, 1970, S.G. Bronevshuk of the U.S.S.R. commented that,

> "We, [Physicists], feel that is is impossible not to study physics; it is the basic science concerning nature. We must teach physics not only to prevent a loss in the essential content of general education, but also because physics is connected with the formation of a basic ideology. Physics affect philosophy, and therefore all members of society must learn the main problems of the physical world" (Brown 1971, 20).

Physics is not only integrated into human life through technology, but also philosophy. However, it is the technology of today that is the most appealing aspect of physics.

Even though most technological advances have been relatively recent, physics has been interwoven into the differing culture's of the world through philosophy. The technological growth of today simply confirms the depth at which physics is part of culture. But society views physics as a science for the elite of the intelligent. Technical terminology and mathematical derivations have acted as deterrents in separating the public from the physical world. In recent years, even more terminology has separated the scientific community from the rest of the world. Technology is advancing so quickly, that today's breakthroughs will be old hat tomorrow. The public is making little or no effort to keep up with these breakthroughs (Purdue, 13). Everyday, people unabashedly admit to being unable to operate microwave ovens, computers and even video games. The majority of society is incapable or unwilling to understand society's prized possessions.

"How often do we hear intelligent leaders of our society almost boasting that they never understood physics. The same people would blush with shame if they could not discourse with depth and understanding on art, literature, and philosophy" (Purdue, 13). With role models such as these pillars of society, it is understandable that the public does not understand physics. "Why, in an increasingly technologically based society, does not that society recognize the cultural values of the science upon which it is coming more and more to rest?" (Purdue, 13).

How can the common wealth value the trinkets provided by a profession, but not the profession itself? Without that profession, the trinkets would be nonexistent or unobtainable by the average household. What can be done to rectify the value of physics in the eyes of the people? The Purdue Research Foundation "[believes] that the reason for the public's image of science in general and physics in particular derives from the attitudes of our schools" (Purdue, 14). Physics is usually only offered to top academic students who have completed numerous math and science classes successfully. To the average student this manner of selection is a statement of inability on their part to grasp the concepts of physics.

Later in life, this selection results in the average person not even trying to understand the latest technological improvements. If schools would change this policy and begin teaching the concepts or applications of physics to all students, maybe as adults these students would not feel so overwhelmed by technology. Physics is not prejudiced, it treats every group and every person the same. Because of this equality, no student should be kept from studying physical concepts (Brown 1971, 139). By changing the attitudes of schools towards science, the views society has concerning physics can be altered.

"Attitudes ... affect the way people attend to ideas and events. People pay attention to what they enjoy, and tend to ignore or misinterpret what they dislike" (Simonson, 3). Changing student attitudes can be accomplished by more student relevant classes. When concentrating on the concepts, numerous thrilling applications are available to enrich physics classes. Many students are so bogged down in the mathematical derivations of the physical laws, that they never bother to decipher what the law means. By emphasizing the conceptual instead of the mathematical aspects of physics, students would be more likely to enjoy physics. Teachers quite often put so much emphasis on the vocabulary of physics that the beauty behind the words is lost to students. While some teachers push math, others stress vocabulary, and still others emphasize facts to the exclusion of exciting applications.

Could the approach of teaching physics as a collection of facts and formulas be wrong? (Purdue, 14). What good will teaching facts to students do? Students who only know facts are ridiculed as being "book smart", although knowing the facts certainly does help a student in the classroom. Being able to recite the coefficients of friction will not help these students later as they try to stop on an icy highway. Students need to know how the facts and formula apply to real-world situations. Physics teaching needs to encompass how to find and use necessary facts and formulae, not how to memorize them. It is the inquiry and problem solving skills learned in physics that benefit students most outside of the classroom (Bowie, 5).

"In [recent] developments, special attention [has been] given to physical concepts and an attempt [has been] made to convey to the student some of the sense of interest and excitement which contemporary physicists find in their subject" (Brown 1966, 182). It is the concepts of physics, not the precise vocabulary or rules, that future citizens need to understand. Physics curriculum changes from nation to nation, as the needs of each nation are different. Not only does the curriculum change from nation to nation, but also from community to community. Each physics course will be slightly or drastically different from the next, depending on the location of the school. All of these courses should develop the students understanding of physical concepts. Also, in spite of the differences between curriculum, all students have the right to an interesting, informative class.

VIDEO MATERIALS FOR THE CLASSROOM

To assist in the creation of worthwhile classes, "Appropriate teaching materials must be created. They must be student-centered. They should use very little mathematics. They should emphasize connections with everyday life and various natural phenomena" (Barajos, 152). These materials may include textbooks, audio-visual aids, and enrichment activities. The teaching materials selected must be carefully screened for effectiveness. One of the most popular audio-visual aids of today is the motion picture or the videotape.

"It has generally been accepted that film viewing is an effective and efficient method for helping students to increase their store of basic facts and concepts" (Bowie, 5). Research on the effectiveness of the filmstrip, or today the videotape, has been going on for about 60 years. In 1931, a study was done that confirmed children's attitudes could be changed by the slant of a motion picture (Simonson, 24). Could filmstrips possibly be used for more than simply demonstrating costly and/or dangerous experiments? Would short videos be effective in changing the attitudes students have toward physics?

Before the *Physics at the Indy 500* project was fully developed, a pilot videotape was tested in Muncie area middle schools. The results, that attitudes and concepts can be changed by media, concurred with other research (Simonson, 25). Through the use of appealing filmstrips, or videotapes, teachers can improve the general attitude students have towards physics. The majority of teachers, however, realize that there is more to a successful class than improving outlooks. Quite often the development of student's cognitive skills is also a goal of the physics teacher. This goal can also be achieved through the use of films. "Film-strips are effective in teaching students the skills of inquiry learning, discovery learning and problem solving" (Bowie, 12). Not only can filmstrips develop reasoning skills, but they can also develop observational skills and improve student self concepts.

Appropriate role models in filmstrips or videotapes can influence minority and female students into the field of physics. At the very least, role models can show that those minorities of physics are capable of understanding the field. Teachers must decide the purpose of showing a filmstrip because of the many applications now available. Only through considerate screening of prospective movies can teachers achieve their intended purpose of using a motion picture. (Bowie, 8-13).

Teachers must consider appropriate topics, lengths, and role models for when choosing filmstrips. Certainly there is more time and thought involved in the selection of classroom media than most people believe. With all the preparation that accompanies a well ordered class, how will teachers manage to choose the best filmstrips and to design a lesson around the choices? The preparation of teacher materials to accompany audiovisual aids can considerably shorten teacher preparation time. Teacher materials that offer hints on lessons, things to be pointed out, and detailed teaching using the film are of invaluable assistance to the teacher. Such materials could offer teachers use of new educational developments, methods and recent attitudes towards a topic (Brown 1971, 140).

With the multitude of audiovisual activities concerning a varied plenitude of topics, an unlimited amount of classroom activities are available for the teacher to choose from. Every day new materials are developed. The selection for teachers to preview becomes larger and larger. With an immense number of possibilities, the teacher can quickly be discouraged when trying to find the audiovisual aids to enhance a class. Albert Baez offers some hints for narrowing down selections in his paper for the AIP Conference of 1987. He suggests that teachers should become involved in the development of teacher materials. By deciding upon objectives, target audience and content teachers will be able to identify other materials that were carefully designed (Barajos, 323).

PHYSICS AT THE INDY 500

Physics at the Indy 500 was such a carefully designed project. The use of physical concepts at the Indianapolis 500 Speedway is the topic of five, one-minute video spots. The spots were designed to attract middle school age students to the field of physics. Each spot is used to discuss a different concept. The five concepts are: the Doppler effect, Newton's third law, conservation of energy, centripetal acceleration, and the Bernoulli effect. One video spot capitalizes on the noticeable change which occurs in the pitch of engine noise heard as a racing car passes the fans. This change is known as the Doppler effect. The one-minute spot on Newton's third law demonstrates how the wide, sticky tires on racing cars accelerate the cars to high speeds. Newton's third law says that for every action force there is an equal and opposite reaction force. The tires push against the race track, which in turn pushes on the tires. The reaction force creates the acceleration for the race car.

The high speeds of the racing cars make collisions deadly. To protect the drivers, the cars are designed to break apart upon impact. The pieces of the car, absorbing the majority of kinetic energy, fall away from the driver who can then walk away unharmed. The curves of the speedway are the focus of the video spot titled *Centripetal Force.* In traveling around a curve, a car experiences a centripetal force. This is the force that helps pull a car around the curve. Racing cars achieve speeds higher than speeds at which many small aircraft become airborne. The final spot explains how the Bernoulli effect allows the airplanes to takeoff and also helps keep the racing cars on the ground.

The videos spots described were designed for two purposes. The Indianapolis Children's Museum has developed an interactive video disc using the spots. The interactive disc will allow children to learn about the five physics concepts at individual learning rates. This video disc will be incorporated into a display in the Museum. All five spots are also available on VHS tape. The tape will be available for teachers to use in the classroom. The teacher materials will accompany the VHS tape. The purpose of the teacher materials is to outline lessons for those teachers having a weak background in physical science. Many middle school teachers feel that they do not have the necessary training to teach a unit in physics.

The teacher materials are to provide teachers with a guideline for using the videos. This guideline is just that, a guideline. It was designed to be a flexible tool for differing classroom needs. The teacher materials were designed to provide teachers with enough material to do an hour lesson on one of the above concepts. The teacher materials are divided into the introduction, and five sections corresponding to the video spots. Suggestions for the layout of each lesson are given in the introduction of the teacher materials. An explanation of the layout of this material was also provided in the introduction, along with an idea for a bulletin board.

The following are included in each video spot's section: objectives, a day before discussion question, a description of the video, detailed explanations of the physics in the video, other example of the physical concept, community connections, hands on exercises, essay test questions, multiple choice test questions, and a worksheet. Answers were provided for the test questions and the worksheets. The test questions and worksheets were designed for photocopying, allowing for easy distribution to the students.

Using this teacher material packet, the teacher can develop lessons for a day, a week or even extend the ideas provided here to cover a longer period. *Physics at the Indy 500* was intended to be used during the month of May when the race is highly publicized. At one time or other, every child has imaginarily been involved in racing. Before an individual can learn about a topic, there must first be an interest in the topic. These spots rely upon children's enthrallment with racing to develop an interest in physics.

Proper use of audiovisual materials, especially motion pictures, should result in "motivating and informing potential learners" of physics (Barajos, 323). Films have been documented to teach facts, change attitudes, and develop problem-solving skills. Because of these varied results, films are extremely beneficial in a classroom. The use of films can help to bridge the gap between scientists and non scientists. All of science needs to be valuable to the population. This value can be achieved by making physics a popular commodity to the public. "The first approach to characterize the popularization of science is that of a bridge which connects the scientist and the general people. By using this bridge, people can be admitted into the scientific world. ... In concrete terms this bridge is established by communication media and by specialist which carry out that task" (Barajos, 325).

THE TEACHER MATERIALS

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